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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of:) Group Art Unit: 2862
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Reisker et al.)
)
Filed: February 5, 2002) Examiner: To Be Assigned
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Serial No. 10/068,300)
)
Confirmation No. 9757) Docket No.: MR/98-003.C
)
For: TAPERED BIRDCAGE RESONATOR)
FOR IMPROVED HOMOGENEITY IN)
MRI) Date: December 16, 2002

COMMISSIONER OF PATENTS
WASHINGTON, D.C. 20231

12/18/2002 SZEWDIE1 00000074 10068300

02 FC:1201 504.00 CH
03 FC:1202 864.00 CH

SECOND

PRELIMINARY AMENDMENT

Sir/Madam:

01/03/2003 UEDUVIJE 00000010 10068300

01 FC:1202 1008.00 CH

Applicants request that the revisions proposed by this *Second Preliminary Amendment*, and those proposed in an earlier-filed *Preliminary Amendment*, be entered on the *Substitute Specification* filed herewith before the Examiner examines the application for patent contained therein. No new matter has been added to the application by virtue of the changes proposed in either the earlier-filed *Preliminary Amendment* or this *Second Preliminary Amendment*.

By way of background, Applicants advise that they filed the above-cited application for patent and a *Preliminary Amendment* therefor on July 18, 2002. Subsequently, Applicants received a *Notice To File Corrected Application Papers*, which was mailed August 16, 2002. The Notice requires the timely filing of "[a] substitute specification in compliance with 37 C.F.R. §1.52" to avoid

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abandonment of the application as originally filed. It noted that the original application papers "contain improper margins."

In response to the Notice, Applicants herewith submit the *Substitute Specification* and a *Petition For Extension Of Time Under 37 C.F.R. §1.136(a)* and the fee therefor. 37 C.F.R. §1.52(c)(1) requires the substitute specification be submitted in accordance with 37 C.F.R. §1.125. Consequently, Applicants hereby state that the *Substitute Specification* contains no new matter (37 C.F.R. §1.125(b)(1)). Be advised that no changes were made in the substitute specification itself, as all changes to the application are to be made only by the earlier-filed *Preliminary Amendment* and this *Second Preliminary Amendment*. Therefore, no marked up copy of the substitute specification is required (37 C.F.R. §1.125(b)(2)).

The TITLE and ABSTRACT have been amended herein to comport with the new claims presented below, all of which have clear support in the application as originally filed. Applicants thus request that the revisions proposed herein to the TITLE, ABSTRACT and the claims be entered on the *Substitute Specification* filed herewith.

IN THE TITLE

Please amend the title to read as follows: --COIL STRUCTURE WITH TAPERED CONDUCTIVE MEMBERS FOR IMPROVED HOMOGENEITY IN MRI--.

IN THE SPECIFICATION

Please amend the ABSTRACT section of the application to read as follows. (This section has been amended in the manner required by 37 C.F.R. §1.121(b)(2). Accompanying this *Second Preliminary Amendment* is Appendix I in which a marked-up copy of the amended section is provided showing all changes (i.e., with the deleted portions bracketed and the additions underlined), pursuant to 37 C.F.R. §1.121(b)(2)(iii).)

ABSTRACT

A coil for creating improved homogeneity in magnetic flux density in a radio frequency resonator for magnetic resonance imaging and spectroscopy of the human head. The coil has a plurality of conductive members. Each of the conductive members has a linear portion and a tapered portion. The conductive members are arranged to form a first opening having a first diameter and a second opening having a second diameter, with the second diameter being different from the first diameter. The tapered portions of the conductive members provide the coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of the coil.

IN THE CLAIMS

Please add claims 46-93 as directed below. (The claims have been amended in the manner dictated by 37 C.F.R. §1.121(c)(1). Because claims have only been added or canceled herein, pursuant to 37 C.F.R. §1.121(c)(1)(ii) no marked up version of the added and canceled claims is provided herewith.)

46. (New) A coil for use with a magnetic resonance (MR) system, said coil comprising:
- (a) a plurality of conductive members each having a linear portion and a tapered portion;

(b) said plurality of conductive members arranged to form a first opening having a first diameter and a second opening having a second diameter different from said first diameter; and

(c) said tapered portions of said conductive members providing said coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of said coil.

47. (New) The coil claimed in claim 46 wherein said coil is a birdcage coil.

48. (New) The coil claimed in claim 46 wherein said second diameter of said second opening is smaller than said first diameter of said first opening.

49. (New) The coil claimed in claim 46 wherein said tapered portion of each of said conductive members comprises at least one angled linear segmented section.

50. (New) The coil claimed in claim 46 wherein said tapered portion of each of said conductive members has a radius that is selected to maximize homogeneity of said magnetic flux density in at least one of an XZ plane and a YZ plane of said orthogonal imaging planes of said coil.

51. (New) The coil claimed in claim 46 wherein said first opening is formed by a first conductive ring and said second opening is formed by a second conductive ring, with said linear and said tapered portion of each of said conductive members being serially connected and thus electrically interconnecting said first and said second conductive rings.

52. (New) The coil claimed in claim 46 wherein said first opening is adapted for accommodating insertion of a head of a patient into said coil.

53. (New) The coil claimed in claim 46 wherein said conductive members of said coil are supported by a housing therefor.

54. (New) The coil claimed in claim 46 wherein said first and said second openings are circular.

55. (New) The coil claimed in claim 46 wherein said first and said second openings are elliptical with said first diameter being a major diameter of said first opening and said second diameter being a major diameter of said second opening.

56. (New) The coil claimed in claim 46 wherein said coil is a receive-only coil.

57. (New) The coil claimed in claim 46 wherein said coil is a transmit/receive coil.

58. (New) The coil claimed in claim 46 wherein said conductive members contain therein a plurality of reactive electrical components.

59. (New) The coil claimed in claim 46 wherein said coil is configured as one of a low pass coil, a high pass coil and a band pass coil.

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60. (New) The coil claimed in claim 46 wherein said coil is operable in one of a linear mode and a quadrature mode.

61. (New) A coil array for use with a magnetic resonance (MR) system, said coil array comprising:

- (a) a first coil having a plurality of conductive members such that:
 - (i) each of said conductive members has a linear portion and a tapered portion;
 - (ii) said plurality of conductive members are arranged to form a first opening having a first diameter and a second opening having a second diameter, with said second diameter being different from said first diameter; and
 - (iii) said tapered portions of said conductive members providing said first coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of said first coil; and
- (b) at least one additional coil at least partially overlapping said first coil at an inferior end thereof to form therewith, and for operation as, said coil array.

62. (New) A coil for use with a magnetic resonance (MR) system, said coil comprising:

- (a) a first end having a first diameter;
- (b) a second end having a second diameter different from said first diameter; and
- (c) a plurality of conductive rods extending between said first and said second ends, each of said conductive rods having a linear portion and a tapered portion with said linear portion being connected to said first end and said tapered portion being connected to said second end, said tapered portions of said conductive rods providing said coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of said coil.

63. (New) The coil claimed in claim 62 wherein said coil is a birdcage coil.

64. (New) The coil claimed in claim 62 wherein said second diameter of said second end is smaller than said first diameter of said first end.

65. (New) The coil claimed in claim 62 wherein said tapered portion of each of said conductive rods comprises at least one angled linear segmented section.

66. (New) The coil claimed in claim 62 wherein said tapered portion of each of said conductive rods has a radius that is selected to maximize homogeneity of said magnetic flux density in at least one of an XZ plane and a YZ plane of said orthogonal imaging planes of said coil.

67. (New) The coil claimed in claim 62 wherein said first end includes a first conductive ring and said second end includes a second conductive ring, with said conductive rods electrically interconnecting said first and said second conductive rings.

68. (New) The coil claimed in claim 67 wherein said first conductive ring and said second conductive ring are each larger in diameter than a center of said coil to thereby enable a concentration of said magnetic flux density to be produced at a region centered within said coil.

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69. (New) The coil claimed in claim 62 further comprising at least one additional coil at least partially overlapping said coil at an inferior end thereof to form therewith, and for operation as, a phased array.

70. (New) The coil claimed in claim 62 wherein said first and said second ends are circular.

71. (New) The coil claimed in claim 62 wherein said first and said second ends are elliptical with said first diameter being a major diameter of said first end and said second diameter being a major diameter of said second end.

72. (New) The coil claimed in claim 62 wherein said coil is a receive-only coil.

73. (New) The coil claimed in claim 62 wherein said coil is a transmit/receive coil.

74. (New) The coil claimed in claim 67 wherein each of said conductive rods and said first and said second conductive rings contain therein a plurality of reactive electrical components.

75. (New) The coil claimed in claim 62 wherein said coil is configured as one of a low pass coil, a high pass coil and a band pass coil.

76. (New) The coil claimed in claim 62 wherein said coil is operable in one of a linear mode and a quadrature mode.

77. (New) A coil for use with a magnetic resonance (MR) system, said coil comprising:

(a) a first end having a first diameter;

(b) a second end having a second diameter; and

(c) a plurality of conductive rods extending between said first and said second ends, each of said conductive rods at each end thereof having a tapered portion, said tapered portions being selected to maximize homogeneity of magnetic flux density in said coil.

78. (New) The coil claimed in claim 77 wherein said first and said second diameters of said first and said second ends, respectively, are equal.

79. (New) The coil claimed in claim 77 wherein said first and said second diameters are each larger than a diameter at a center of said coil such that said tapered portions of said conductive rods are tapered outwardly.

80. (New) The coil claimed in claim 77 wherein said first and said second diameters are each smaller than a diameter at a center of said coil such that said tapered portions of said conductive rods are tapered inwardly.

81. (New) The coil claimed in claim 77 wherein said coil is a birdcage coil.

82. A method of designing a coil capable of exhibiting a substantially homogeneous pattern of magnetic flux density while at least one of avoiding substantial degradation of, maintaining and improving signal-to-noise ratio performance, said method comprising the steps of:

- (a) providing a model of a conventional resonator, said conventional resonator having a first end and a second end between which extend a plurality of conductive rods;
- (b) ascertaining said magnetic flux density within said resonator; and
- (c) adjusting a geometry of at least one of said first end, said second end, and said conductive rods to improve the homogeneity of said magnetic flux density and thereby form said coil.

83. (New) The method as claimed in claim 82 wherein said coil is a birdcage coil.

84. (New) The method as claimed in claim 82 wherein said first end includes a first conductive ring and said second end includes a second conductive ring, with said conductive rods electrically interconnecting said first and said second conductive rings.

85. (New) The method as claimed in claim 82 wherein the step of providing a model of a conventional resonator comprises using a wire model thereof.

86. (New) The method as claimed in claim 82 wherein the step of ascertaining said magnetic flux density involves at least one of Biot-Savart modeling and experimental verification.

87. (New) The method as claimed in claim 82 wherein the step of adjusting involves changing at least one of (i) a diameter of said first end, (ii) a diameter of said second end and (iii) a radius of a taper of said conductive rods at least at one end thereof.

88. (New) The method as claimed in claim 82 wherein the step of adjusting optionally applies to a length of said conductive rods when said signal-to-noise ratio performance of said coil is less important.

89. (New) The method as claimed in claim 82 wherein the step of adjusting is performed iteratively.

90. (New) The method as claimed in claim 82 further comprising the step of adjusting a volume of said coil to improve said signal-to-noise ratio performance thereof.

91. (New) A birdcage coil for use with a magnetic resonance (MR) system for at least one of obtaining images of a region of interest and ascertaining the spectra of said region of interest during an MR scanning procedure, said birdcage coil comprising:

(a) an inferior end having a first diameter through which said region of interest is provided access to said birdcage coil;

(b) a superior end having a second diameter smaller than said first diameter of said inferior end; and

(c) a plurality of conductive rods extending between said inferior and said superior ends, each of said conductive rods having a linear portion and a tapered portion with said linear portion being connected to said inferior end and said tapered portion being connected to said superior end, said tapered portions of said conductive rods providing said coil with a substantially homogeneous pattern of magnetic flux density in at least one of three imaging planes of said birdcage coil while at least one of maintaining and improving a signal-to-noise ratio of said birdcage coil.

92. (New) The birdcage coil claimed in claim 91 wherein said inferior end includes a first conductive ring and said superior end includes a second conductive ring, with said conductive rods electrically interconnecting said first and said second conductive rings.

93. (New) The birdcage coil claimed in claim 91 wherein said tapered portion of each of said conductive rods has a radius that is selected to maximize homogeneity of said magnetic flux density in at least one of an XZ plane and a YZ plane of said imaging planes.

REMARKS

In this *Second Preliminary Amendment*, claims 46-93 have been added. The added claims cover subject matter previously disclosed in the text of the present application as originally filed. The ABSTRACT section has been revised herein to comport with the invention claimed in this continuation application. No new matter has been added to the present application by virtue of this *Second Preliminary Amendment*. Procedurally, all of the amendments made herein comply with the requirements of 37 C.F.R. §1.121. Applicants submit that the application is in condition for allowance.

I. New Claims 46-93 Based On Subject Matter Previously Disclosed in Present and Parent Applications

Applicants respectfully submit that the claims in this *Second Preliminary Amendment* add no new matter to the present application.

The revisions made herein have support in both the present application and the parent application on which it is based. Because MPEP §2163.06 and MPEP §2163.07 are dispositive on this issue, Applicant quotes the relevant sections thereof as follows:

MPEP § 2163.06 Relationship of Written Description Requirement
To New Matter

* * * If an applicant amends ... the abstract, specification or drawings of an application, an issue of new matter will arise if the content of the amendment is not described in the application as filed. Stated another way, *information contained in any one of the specification, claims or drawings of the application as filed may be added to any other part of the application without introducing new matter.* (emphasis added)

MPEP §2163.07 Amendments to Application Which Are Supported in
the Original Description

Amendments to an application which are supported in the original description are NOT new matter. (emphasis in original)

Applicants point out that the subject matter recited in new claims 46-93 was described in the present application as originally filed. Applicants also point out that the same subject matter was also described in the parent application, i.e., U.S. Application Serial No. 09/449,256, filed November 24, 1999, which issued as U.S. Patent 6,344,745 on February 5, 2002. The claimed subject matter also has support in the provisional application on which both the present and parent applications are based, namely, U.S. Provisional Application Serial No. 60/109,831, November 25, 1998.

Based on the foregoing, Applicants respectfully request examination of new claims 46-93.

CONCLUSION

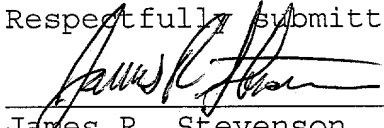
The *Substitute Specification* submitted herewith has been filed in response to a *Notice To File Corrected Application Papers*, which was mailed August 16, 2002. The *Substitute Specification* overcomes the deficiencies cited in the *Notice*, and thus places the above-cited application in compliance with 37 C.F.R. §1.52.

Be advised that, in the earlier-filed *Preliminary Amendment*, claims 1-17 were canceled and claims 18-45 were added and paid for.

In this *Second Preliminary Amendment*, Applicants now add claims 46-93 (i.e., six (6) independent claims and forty-two (42) dependent claims) to the application for which payment is made herewith. Consequently, upon entry of this *Second Preliminary Amendment*, the application will contain seventy-six (76) claims total: ten (10) independent claims and sixty-six (66) dependent claims.

If the Examiner has any questions regarding the *Substitute Specification*, this *Second Preliminary Amendment* or the earlier-filed *Preliminary Amendment*, he/she is invited to call the undersigned at the telephone number listed below.

Respectfully submitted,


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APPENDIX I

MARKED-UP COPY OF REVISED SECTIONS OF APPLICATION

(Provided pursuant to 37 C.F.R. §1.121(b)(2)(iii))

ABSTRACT

A [method] coil for creating improved homogeneity in magnetic flux density in a radio frequency resonator for magnetic resonance imaging and spectroscopy of the human head. The coil has a plurality of conductive members. Each of the conductive members has a linear portion and a tapered portion. The conductive members are arranged to form a first opening having a first diameter and a second opening having a second diameter, with the second diameter being different from the first diameter. The tapered portions of the conductive members provide the coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of the coil. [A tapered birdcage resonator is also provided. The tapered birdcage resonator includes two electrically conductive rings and a plurality of rods or conductor legs. The first electrically conductive ring forms an inferior end of the coil. The plurality of legs extends from the first electrically conductive ring. Each of the plurality of legs has a linear portion and a tapered portion. The second electrically conductive ring forms a superior end of the coil and is connected to the tapered portion of the plurality of legs.]

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